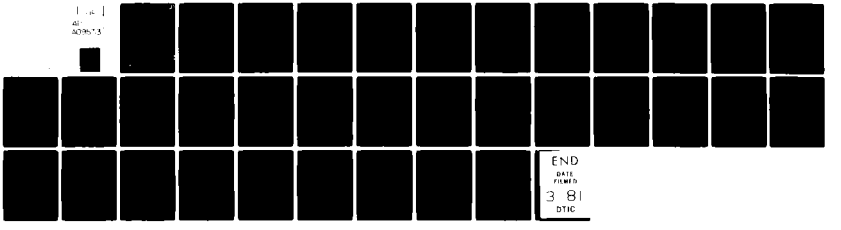
AD-A095 713 LOGISTICS MANAGEMENT INST WASHINGTON DC F/G 21/4
THE DEVELOPMENT OF SYNTHETIC FUELS: DEPARTMENT OF DEFENSE LOGIS--ETC(U)
NOV 80 C D STEVENSON MDA903-77-C-0370
UNCLASSIFIED LMI-ML010 NL



END
DATE FILMED
3 81
DTIC

THE DEVELOPMENT OF SYNTHETIC FUELS: DEPARTMENT OF DEFENSE LOGISTICS IMPLICATIONS

November 1980

Connelly D. Stevenson

Prepared pursuant to Department of Defense Contract No. MDA903-77-C-0370 (Task ML010). Views or conclusions contained in this document should not be interpreted as representing official opinion or policy of the Department of Defense. Except for use for Government purposes, permission to quote from or reproduce portions of this document must be obtained from the Logistics Management Institute.

LOGISTICS MANAGEMENT INSTITUTE
4701 Sangamore Road
Washington, D.C. 20016

EXECUTIVE SUMMARY

The Energy Security Act provides the Department of Defense with an opportunity to increase the assurance of its fuel supply and with the responsibility to be the major early consumer of synthetic fuels, helping prime a new domestic industry. The responsibility will dominate for several years; it will take at least that long for the opportunity to reach fruition.

The synthetic fuel production targets of the Energy Security Act are ambitious--a half million barrels of synthetic crude oil per day by 1987, two million barrels per day by 1992. The Act provides for several methods to accelerate the development of the synthetic fuels industry. Most of the stimulation devices involve government backing for the capital investment needed. The Department of Defense has been charged with providing a guaranteed market for the synthetic fuels produced during the stimulation effort.

In response to its legal obligation, the Department of Defense has indicated readiness to accept synthetic fuels starting with almost six million barrels in 1981. This amount represents about 3% of the present annual consumption and would be used to continue mobility fuels testing programs and to replace residual petroleum boiler fuels. Over the next four years the application would shift from fuels testing to operational use and the annual volume would grow to 83 million barrels, almost half the present consumption.

The synthetics fuel industry will probably not develop fast enough to meet the Energy Security Act production goals. Several factors--economic,

socioeconomic, institutional and environmental--combine to impede industry growth and to make accurate forecasting of the industry growth rate impossible. It is possible that even the Department of Defense requirements will not be met. The modest amounts needed to complete comprehensive Defense Department test programs should, however, be available.

In any case, as the industry develops toward commercial production levels, and increasing amounts of synthetic fuels are available, the Defense Department's concerns in the synthetic fuel area will shift from testing to logistics--acquisition, storage and distribution.

Focusing on the logistics aspects of the Defense Department's opportunity and obligation in the development of the synthetics fuel industry, we recommend that the Office of the Deputy Assistant Secretary of Defense (Energy, Environment and Safety) take the following actions:

- With the assistance of the Deputy Under Secretary of Defense (Research and Advanced Technology) (DUSD (R&AT)) and the Commander, Defense Fuel Supply Center (DFSC), develop a detailed, priority-ranked list of synthetic fuel requirements to satisfy all testing programs.

- With the assistance of the Commander, DFSC, develop a basic, incremental profile for the operational introduction of synthetic fuels.

- With the assistance of the DUSD(R&AT) and the Commander, DFSC, reevaluate synthetic fuel consumption projections at least annually to update acquisition and distribution planning.

- Plan for the transfer of primary responsibility for the synthetic fuel program from the research community to the logistics community at an appropriate time during the transition from test use to operational consumption of synthetic fuels.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The Department of Defense (DoD) has been one of the few major petroleum consumers whose interest in the potential of alternative fuels pre-dated their widespread attention. The DoD has conducted long-term programs to determine the feasibility of using shale-derived fuels as an alternative to petroleum-based fuels. In concert with each other, and with other interested federal agencies such as the National Aeronautics and Space Administration and the Department of Energy (DOE) (then the Energy Research and Development Administration), the individual Military Services have tested oil shale fuels in a wide range of mobility applications since 1970.

The DoD's long-term interest in oil shale as a potential source of liquid fuel has been seized upon by the Congress as a means of stimulating a new industry. The Defense Production Act (DPA) Amendments of 1980[1] states that "... in order to encourage and expedite the development of synthetic fuel for use for national defense purposes, the President, ..., shall take immediate action to achieve production of synthetic fuel to meet national defense needs...."

The DPA Amendments of 1980 are explicitly named the "'Fast Start' Interim Synthetic Fuel Authorities" by the Conference Committee's Joint Explanatory Statement. The Statement enjoined the DoD to "... provide the Secretary of Energy as rapidly as possible with its total requirements for mobility synthetic fuels and other alternative fuels by specification and quantity and the rate at which they are required for use in lieu of conventional fuels." This obligation, along with elaboration in both the ESA and the Joint Explanatory Statement and confirmation in an Executive Order on the subject of synthetic

[1] Title I, Part A of the Energy Security Act, entitled "Development of Synthetic Fuel Under the Defense Production Act of 1950," is cited as the "Defense Production Act Amendments of 1980." The quote is from Section 305 of the DPA Amendments.

fuels,[2] assigns DoD a major responsibility. DoD is obliged to accept and consume synthetic fuel to provide a market pull on the industry. But isn't this more of an opportunity than a responsibility? Doesn't the DoD's provision of a guaranteed market for a developing synthetic fuels industry equate to a significant step toward domestic supply assurance for military fuel needs? The answers to those questions are complex and dependent on factors which are not predictable.

Perhaps the only acceptable answer is that the required DoD role both assigns a responsibility and provides an opportunity. The DoD does not have a real requirement for synthetic fuels, but rather a requirement for fuels meeting military specifications, irrespective of the fuel source. Since a synthetic fuels industry represents a potential source for those fuels, the DoD must be prepared to use them. The requirement to be an early major consumer of synthetic fuels therefore not only establishes the initial increment of a market, without which the industry could not develop, but also provides the means for the DoD to carry out a more comprehensive fuels testing program than would be otherwise possible.

The synthetic fuels test programs in the DoD are well established. Their goals are basically to validate the acceptability of shale-derived fuels in military engines. But what are the logistics implications of the introduction of synthetic fuels? Will procedures now used to acquire, store and distribute petroleum-based fuels be suitable for synthetic fuels as well?

This report examines some of the factors which must be addressed in order to answer these questions.

---

[2]Executive Order 12242 of September 30, 1980, Synthetic Fuels, Federal Register, Vol. 45, No. 193, pp. 65175,6.

BACKGROUND

No subject on the national energy scene is as fast moving as synthetic fuels. Since the 1973 oil embargo, energy has become a national fixation. Several factors--the decline of domestic petroleum production, the unreliability of foreign petroleum sources, and the rapidly increasing cost of foreign and domestic oil--have brought the potential of unconventional fuel sources into popular awareness, and led to a demand for strong national action. One such action taken in the 96th Congress was the creation of a mechanism to stimulate the production of synthetic fuels.

The supply of military petroleum products from conventional sources is already a complex undertaking. The introduction of synthetic fuels into operational use will further complicate it. Some of the factors contributing to the complexity of DoD fuel acquisition, storage and distribution are the following:

- Military specifications. To many observers, jet fuel is jet fuel. Nevertheless, the DoD requires jet fuels with characteristics different from those of commercial jet fuel, and furthermore the primary jet fuel of the Air Force, JP4, differs from that of the Navy, JP5. Some reasons for the unique characterics of military jet fuel are:

  -- The profile of Air Force missions requires that the fuel for its long range aircraft have a lower freezing point than that required by commercial planes and even by Navy jets which characteristically fly at lower (warmer) altitudes.

  -- Whereas the smoke generated by commercial aircraft is simply an environmental pollutant, smokeless combustion to prevent detection is a significant military requirement.

  -- The necessary proximity of jet fuel storage to weapons handling and storage and to aircraft operation aboard ship requires a higher flash point fuel for the Navy than is necessary in commercial or even Air Force applications.

- New competition for refinery fraction. Until the automobile transportation segment of the petroleum market was mandated into the use of unleaded gasoline, middle distillate range of fuels was a relative excess fraction. The turbine fuel market was a buyers' market, and the Defense Fuel Supply Center, responsible

for the bulk contracting of all military fuels, had its pick of the "distressed" product for a low price. Unleaded gasoline and turbine fuel come from the same refinery cut. The new demand for unleaded motor gasoline reduced the available yield of jet fuel and initiated a competition for the formerly excess refinery fraction, exacerbating simultaneously the pressure on price and availability of turbine fuel to DoD.

- Requirement to maintain "fenced" wartime reserves. The nature of military readiness dictates prepositioned equipment and supplies to allow for immediate military operations in case of war. Prepositioned fuel must be stocked in locations and quantities such that immediate overseas wartime or contingency needs can be met while mobilization of fuel production and transportation capacity is undertaken. Since the consumption rate of petroleum in wartime scenarios is so much higher than that required by peacetime operations, the petroleum reserve maintained under current doctrine appears to be very high, standing about 60-70% of the global inventory at any time, or about 35% of the current annual (peacetime) consumption. That level is higher than normal petroleum stockpiles in the commercial or industrial sector, higher than the domestic Strategic Petroleum Reserve (SPR) target, and significantly higher than the present or near-term SPR levels.

Federal momentum to create a domestic synthetic fuels industry, partially funded by anticipated revenue from the "windfall profit" tax, increased through 1979. By the spring of 1980, there were nine separate bills proposing the establishment of a synthetic fuels industry before Congress. P.L. 96-294, the Energy Security Act (ESA), was reported out of conference committee and enacted in June and immediately signed into law. It provides a vehicle for massive federal subsidization to get the industry quickly to a commercially viable level and requires the Defense Department to consume the initial output of the developing industry.

INDUSTRY DEVELOPMENT RATE

The rate at which the domestic synthetic fuels industry will grow is impossible to predict. Many of the factors which will control the growth rate are complex and interdependent. Projecting the effect of specific individual factors is a subject of professional controversy. Readiness of various synthetic fuel technologies is not uniform. Within each general area of

synthetic fuel production, such as coal gasification, coal liquifaction, shale oil, there are a number of processes. Some, e.g. the Fischer-Tropsch synthesis process, the H-coal liquefaction process and several above-ground oil shale retorting processes, have been or are about to be technically demonstrated at the commercial pilot plant level. Others, including many coal liquifaction and gasification processes, and all the in situ oil shale retorting processes, have not yet reached a stage where commercial scale operation is feasible.

Availability of land, especially federally held land in the shale rich western states, is piecemeal; the extensive contiguous tracts needed for commercial scale production are not yet available. The water requirements for development of shale resources are huge. Production of shale crude from the western states could be limited to about 500,000 barrels per day unless new supplies of ground water or diversions of surface water (from the White and Colorado Rivers) are undertaken on a large scale.

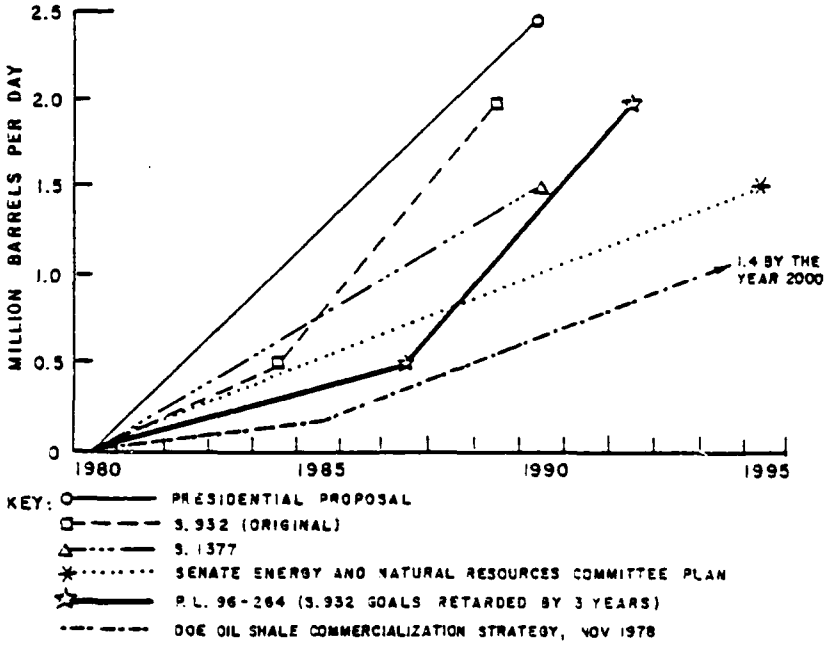
Engineering materials and labor, not only for the industrial development but also for the expansion of communities necessary to support the industrial growth, will be needed at a level which will tax the domestic heavy construction industry. The eventual integrated ecological effect of a developed industry are uncertain.

Evaluation of individual factors--technological readiness, capital availability, product marketability, water availability, environmental and socio-economic effects, etc.--is difficult. Forecasting the effect of all the factors in combination can not yet be done. The consensus of knowledgeable estimates however is that the national synthetic fuel production goals established in Section 125 of the ESA--at least 500,000 barrels of synthetic crude oil per day by 1987 and 2,000,000 barrels per day by 1992, from domestic sources--will not be achieved. Figure 1 depicts some of the production rates

that were under consideration as possible national targets and shows the Energy Security Act goals.

Figure 1

SYNTHETIC FUEL PRODUCTION RATE TARGETS
OF VARIOUS LEGISLATIVE PROPOSALS AND P.L. 96-264



NOTE:

For the purpose of comparative illustration, all production rates are shown at zero at the time of enactment of P.L. 96-264, and curves show the average increases of production rates required to meet the various goals.

Three independent assessments of the feasibility of various industry development rates are summarized in Appendix A. The authors of the reports are from three different sectors--government, commercial, and academic. Each assessment took technological, financial, labor supply, and several institutional and environmental factors into consideration. The urgency of the national requirement is addressed at least to some degree in each. The assessments strongly imply that production levels called for in the ESA are not feasible.

INDUSTRY DEVELOPMENT COST

If left to private industry, synthetic fuels would enter the market as they become cost competitive with conventional fuels. However, the 96th Congress determined that it would take too long for synthetic fuels to become competitive and that government stimulation through financial assistance is required.

Many experts have estimated the potential prices for various types of synthetic fuels. Some estimates show prices close to current crude prices and others show synthetic fuels, including shale oil, costing two to three times current crude oil prices. As synthetic fuel production rises, some economies of scale should be realized, leading to declining production costs. However, if the production schedule is accelerated, the emerging industry may run into constraints on the availability of trained manpower, various construction materials and raw materials. These constraints will lead to higher production costs, potentially overwhelming any near-term economy of scale benefits. There is also some question as to whether the existing distribution system can handle the new fuels. It is almost certain that some new transportation and storage facilities will be needed, increasing the likelihood of higher cost.

The ESA states that DoD will not pay more than the prevailing market price of the replaced fuel, as determined by the Secretary of Energy, for the synthetic fuel it accepts. Thus, at least during the stimulation period, the DoD will not be directly affected if synthetic fuels turn out to be very costly. However, the DoD could be indirectly affected in terms of its future investments. When DoD uses the ficticious "market price" for fuel in its life cycle cost calculations, the possibility of an incorrect investment decision arises. In other words, programs which would not be accepted if the "true price" of fuel were used might be accepted when the "market price" was used.

The legislation does not make clear how long DoD will pay only the market price of replaced conventional fuels for synthetic fuels. It seems realistic to assume that many of the cost calculations made for DoD's budgeting and investment decisions will contain serious errors in fuel prices.

The ESA provision that DoD will pay only the market price of the replaced fuel does not establish that the indirect cost factors, such as the tailoring of fuel to military specification and its transportation to normal military distribution network terminals, as well as the direct cost of basic fuel processing and refining will be covered by the price support provisions of the Act. If the normal defense appropriations must bear these costs as part of DoD's responsibility to guarantee a market for synthetic fuel, DoD will be immediately and directly affected.

LOGISTICS IMPLICATIONS OF INTRODUCING SYNTHETIC FUELS

The answer to whether the introduction of synthetic fuels to the domestic energy supply menu will cause a logistics problem to the DoD depends primarily on two factors, neither of which is predictable. Their resolution should be of paramount interest to the DoD, and of significant interest to DOE and to the potential synthetic fuels industry as well.

The first of these factors can be stated roughly as a question: Will the stimulation of the synthetic fuels industry include integration of the new sources into the established fuels distribution network? If each project is considered a separate entity, with no plan for coupling its product--raw shale oil, upgraded shale crude, tar sands crude, etc.--into the refinery feedstock collection, refinery, and downstream distribution systems, then the new industry will have been incompletely stimulated and developed. The DoD and, indeed, the nation as a whole will have a logistics problem.

The other factor is of immediate importance to DoD. It can also be stated as a question: Will fuels produced for the same end purpose, but from different sources, be intermixable? If the answer to this question is "yes," then the DoD logistics problems is merely the accommodation of new fuel supplies by the Defense Fuel Supply Center.

If it develops, however, that JP4 (from conventional sources) and "JP4S" (from oil shale) and other possible but unlikely jet fuels "JP4C" (from coal) and "JP4T" (from tar sands) must be segregated during transportation and storage, then the logistics problem is compounded. Cooperative work among engine builders, petroleum and synthetic fuel producers, military fuel specification writers, and the military R&D, logistics and operations communities will be required to keep fuel source insensitivity, in storage and distribution systems as well as in engines, as an important goal of the synthetic fuels industry.

In recent shale oil development initiatives, no consuming sector has been more aggressive than the DoD in seeking to facilitate the introduction of shale products into its fuel supply stream. The Air Force and the Navy, DoD's principle users of middle distillate fuels, have coordinated shale oil test programs aimed at determining the compatibility of shale-derived fuels and military engines. In general, Service test programs are attempting to collect information on the critical properties of synthetic fuels--combustion characteristics, freezing point, flash point, etc.--and on the long-term compatibility of engines and the new fuels. Since few data are available on shale fuel properties, in comparison to the knowledge of petroleum fuel properties, most of the test fuels are 100% shale-derived. As test data on shale fuels accumulate, characteristics of a broad range of conventional fuel-shale fuel blends will be capable of estimation by extrapolation and verification by less

comprehensive test programs than those necessary for the pure shale fuel. The goal of the testing is essentially to determine engine insensitivity to the source of a specified fuel. The development of specific treatments or additives for alternative fuels is also an objective.

The test volumes of shale fuels have been acquired, processed, refined, and delivered by individually tailored contracts suitable for the relatively small volumes required. The processes which will be used to acquire, store, and distribute operational volumes of fuel are not receiving attention proportional to their forthcoming importance. It may yet be necessary to show whether storage and distribution methods in use for conventional fuel are usable for shale fuels and blends as well, and whether fuels used for the same end purpose must be segregated according to source.

The degree of insensitivity of engines to the source of their fuels is *the major question affecting the operational use of synthetic fuels.* Intermixability of synthetic with conventional fuels will dominate their logistics accommodation. The rate of availability of synthetic fuels to the DoD will influence both operational and logistics concerns. If plant construction rather than fuel production characterizes the initial few years of industry development, military test programs may not be fulfilled. Operational and logistics questions may not have been answered in time to accommodate higher rates of supply from the industry if production rate growth accelerates after the initial few years.

On 4 August 1980, the DoD advised the Secretary of Energy of its current petroleum-based fuels consumption statistics and requirements for synthetic fuels projected through 1985.[3] Table 1 presents a summary and analysis of current DoD petroleum consumption.

---

[3]Deputy Assistant Secretary of Defense (Energy, Environment and Safety) letter of 4 August 1980 to the Assistant Secretary of Energy for Resource Applications.

TABLE 1. DOD CURRENT CONSUMPTION OF PETROLEUM FUELS BY PRODUCT

	JP 4	JP 8	JP 5	AVGAS	DFM	DF2+[1]	NFSO	RESID[2]	MOGAS	Total
Current Annual Consumption (1000 BBLS/Yr)	91,000	3,600	20,022	1,023	23,232	14,920	1,296	10,598	5,714	171,505
Percent of Total Petroleum Consumption (%)	53	2	12	1	14	9	1	6	3	101[3]
Current Annual CONUS Consumption (1000 BBLS/Yr)	74,400	0	16,115	869	7,199	9,436	266	9,408	2,923	120,616
CONUS Consumption Percentage of Product Consumption (%)	82	0	81	85	31	63	20	89	51	-
CONUS Product Consumption as Percentage of Total Petroleum Consumption (%)	43	0	12	<1	4	5	<1	5	2	72

NOTES:

[1] DF2+ means "all other distillate fuels".

[2] RESID means "all other residual fuels".

[3] Total not equal to 100 because of rounding.

Source of Raw Data: DASD(EES) letter of 4 August 1980 to Assistant Secretary of Energy for Resource Applications

Table 2 presents a summary and analysis of the DoD's reported synthetic fuels requirements. Figure 2 illustrates the national synthetic fuels production goals expressed by the ESA and shows the increasing DoD synthetic fuels commitment, reaching 48% of the current DoD total petroleum consumption by 1985. There is a clear implication that the DoD intends to meet its responsibility to provide the initial market pull on the synthetic fuels industry.

It will be important for the DoD to anticipate the synthetic fuels production rate, or availability rate, in order to adjust test programs or operational introduction rates. The 4 August DoD synthetic fuels requirement outlook, Table 2, should be viewed as an estimate, and not as a statement of maximum or minimum needs. The DoD and the DOE should take a flexible approach to the rate at which DoD accepts synthetic fuels. Once the first round of

TABLE 2. SYNTHETIC FUEL REQUIREMENTS DECLARED BY DOD

(Amounts in 1000 BBLS)

	JP-4	JP-8	JP-5	AVGAS	DFM	DF2+	RESID	MOGAS	Total
1981 SYNFUEL REQUIREMENTS									
For Test Use	48	0	11	0	31	2	0	0	92
For All Uses	48	0	11	0	31	2	5,000	714	5,806
A Percent of Year's Total Synfuel Requirement	1	0	<1	0	<1	<1	86	14	101*
B Percent of Product's Current Consumption	71	0	<1	0	<1	<1	47	13	1
C Percent of Product's Current CONUS Consumption	71	-	<1	0	<1	<1	53	24	5
1982 SYNFUEL REQUIREMENTS									
For Test Use	58	0	10	0	30	16	0	0	114
For All Uses	58	0	10	0	30	16	5,000	1,000	6,114
A Percent of Year's Total Synfuel Requirement	1	0	<1	0	<1	<1	82	16	100
B Percent of Product's Current Consumption	<1	0	<1	0	<1	<1	47	18	4
C Percent of Product's Current CONUS Consumption	<1	-	<1	0	<1	<1	53	34	5
1983 SYNFUEL REQUIREMENTS									
For Test Use	3,500	0	0	0	0	0	0	0	3,500
For All Uses	7,000	0	5,000	1,023	5,000	7,000	5,000	2,000	32,023
A Percent of Year's Total Synfuel Requirement	22	0	16	3	16	22	16	6	101
B Percent of Product's Current Consumption	9	0	25	100	22	47	47	35	19
C Percent of Product's Current CONUS Consumption	9	-	31	118	69	74	53	68	27
1984 SYNFUEL REQUIREMENTS									
For Test Use	7,000	0	0	0	0	0	0	0	7,000
For All Uses	25,000	1,800	10,000	500	11,000	7,000	5,000	2,700	63,000
A Percent of Year's Total Synfuel Requirement	40	3	16	1	18	11	8	4	101*
B Percent of Product's Current Consumption	27	50	50	49	47	47	47	47	37
C Percent of Product's Current CONUS Consumption	34	X	62	58	153	74	53	92	52
1985 SYNFUEL REQUIREMENTS									
For Test Use	0	0	0	0	0	0	0	0	0
For All Uses	45,000	1,800	10,000	500	11,000	7,000	5,000	2,700	83,000
A Percent of Year's Total Synfuel Requirement	54	2	12	1	13	8	6	3	99*
B Percent of Product's Current Consumption	49	50	50	49	47	47	47	47	48
C Percent of Product's Current CONUS Consumption	61	X	62	58	153	74	53	92	69

NOTES

"DF2+ means "All other distillate fuels"

"RESID means "All other residual fuels"

[3]For All Uses is the combination of operational and test requirements for the specific fuel product shown.

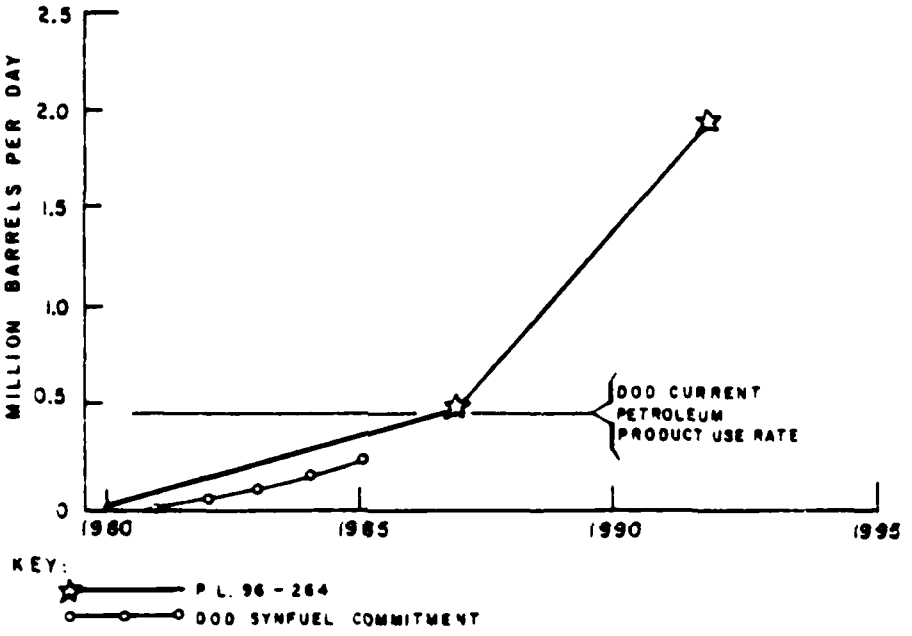
*Total does not equal 100 because of rounding

Source of Raw Data: DASD(EES) letter of 4 August 1980 to Assistant Secretary of Energy for Resource Applications.

industry proposals is analyzed, it may be necessary to significantly adjust the DoD commitment.

Figure 2

SYNTHETIC FUEL PRODUCTION RATE TARGETS
P.L. 96-264 AND DOD COMMITMENT



Comparison of the present DoD petroleum consumption profile, Table 1, and the projection of DoD synthetic fuels requirements, Table 2, suggests that flexibility is needed in the determination of DoD synthetic fuels acceptance rate. Some specific points emerge.

Adjusting for Uncertainty in the Availability of Synthetic Fuels

It is unlikely that the total synthetic fuel requirements projected by the DoD from 1981 to 1985 will be met. As long as test fuel needs are met, further shortfalls, i.e., insufficient synthetic fuels to meet identified "operational" requirements, are not a problem for the DoD. But there are some

supply-demand mismatch situations which may represent problems to DoD and should be resolved.

First, the synthetic fuel industry may not develop in a timely, gradual manner. DoD requirements are based on a schedule of testing followed by phased introduction of synthetic fuels into operational uses. The growth of production capacity will probably be step-wise, however, as individual commercial-size plants come on stream. Until the first commercial-size increment is added to the supply, there may be insufficient synthetic fuel available to fulfill the test requirements. The probability that the emerging production path may present a problem exists according to the Division of Fuel Extraction, DOE, which warns that the DoD "will face problems in conducting engine tests in the near term because of the lack of shale oil which will be representative of long term production. Although the DoD can probably conduct the engine tests in-house, shale oil production and refining will have to be done on a contract basis."[4] If only small quantities are available, DoD can postpone some of the lower priority testing until the production rate grows.

The next period of supply-demand mismatch potential is initiated by the first of the newly built plants starting commercial scale production. If several plants come on stream over a short period of time, causing a strong surge in the rate of supply, a glut may result because DoD is not able to accept the surge without having had prior access to moderate quantities for testing.

The eventual supply-requirement mismatch which will occur is the one in which the supply of synthetic fuels exceeds the total requirements, test and operational, of the DoD. This long term situation is hardly a DoD problem, but rather the expected result of the national program. However, if the

[4]Market Assessment for Shale Oil, (DOE/ET-2628/1, UC-91), Pace Consultants and Engineers, Inc. and Booz-Allen and Hamilton, Inc., October 1979.

supply exceeds the total DoD synthetic fuel requirements during the period in which their unsupported prices are higher than the market prices of their counterpart conventional fuels, then a problem for DoD may result. The problem would arise from pressure on the federal government to consume the more expensive but subsidized fuel, and the focusing of that pressure on the major federal fuel consumer, the DoD.

The integrated solution to these potential supply-demand mismatch problems is for the DoD to have a flexible, incremental requirements schedule. Starting with a baseline projection, such as that forwarded to DOE on August 4, 1980, incremental increases or reductions in the demand profile should be planned. These "building blocks" would then be available to accelerate or decelerate DoD consumption, in an orderly fashion, in response to the availability of synthetic fuels. The DoD should identify the minimum acceptable level of synthetic fuels needed to maintain test programs, and should press DOE for fulfillment of this minimum by output from DOE's ongoing shale oil technology Research, Development and Demonstration programs and the DPA-stimulated sector. The DoD should be prepared to contract for the production and refinement of synthetic fuels, as in the past, to keep the military test programs on track.

Some of the consumption building blocks which could be used to modify the DoD consumption rates would come from adjustments to the August projection based on assessment of the following considerations:

JP8. The present statement of synthetic fuels requirements includes no early test amounts, but 1984 and 1985 operational requirements of 1.8 million barrels each, half the present consumption rate. Since JP8 is a Jet 1A, commercial-like fuel, with different characteristics from JP4, the implied

intention of direct service operational use without prior testing is questionable. It is expected that a statement of an earlier test requirement would intensify the market stimulation, and would allow synthetic JP8 testing before operational introduction.

AVGAS. As in the case of JP8, there is an apparent lack of intention to test the synthetic fuel prior to operational use. If the availability of synthetic fuels is so meager as to preclude general distribution, synthetic AVGAS will not be commercially tested and ready by 1983 to satisfy 100% of the present military consumption.

Residual Fuels. The present statement of requirements indicates a readiness for DoD to use synthetic fuel to fulfill half its needs for residual fuels. Although shale oil can be used in industrial or utility boilers without the prior severe processing needed to produce middle distillates, it is anticipated that significant testing will be required to demonstrate reliable pollution emission control techniques. The Electric Power Research Institute has previously collaborated with the DoD in testing shale-derived industrial fuel. Continuation and expansion of this program, using DoD furnished fuels, could provide incremental demand flexibility for residual fuels.

Another potential building block of synthetic fuel usage exists. Currently, most DoD fuel tests are conducted within the Military Services. There have been instances in which engine manufacturers have requested and received shale-derived fuel for developmental engine testing, but that practice has accounted for only a small proportion of the synthetic fuels used for tests. The DoD should consider providing synthetic fuels to the turbine engine industry so that manufacturers' test programs for liquid hydrocarbon fueled engines under development for military application could include alternative fuels. Not only would such a practice provide earlier information

on alternatively fueled engine performance, but also the volumes required would represent an additional demand for synthetic fuel. This incorporation of government-furnished synthetic fuel into manufacturers' test programs could be an additional incremental use of synthetic fuel in the overall flexible consumption plan, another hedge against a higher than projected supply or a lower than planned consumption of synthetic fuels in the next few years.

Geographic Factors in DoD Synthetic Fuels Consumption

There are two geographic factors which could affect the use of synthetic fuels in the DoD. The first factor is a legal one, and stems from the wording of the ESA. Title I, Section 305(C)(2) specifies assuring "the availability to the United States of supplies overseas for use for national defense purposes" (emphasis added). Analysis of DoD consumption of petroleum fuels shows that about 70% of all fuel and about 80% of jet turbine fuel (except JP8) are consumed in the United States. The DoD should insure that the ESA specification of overseas use will not be an impediment to DoD exploitation of synthetic fuel.

The other geographic factor also emerges from the analysis of DoD petroleum consumption. Virtually all JP8 is procured and consumed abroad. The prospect of domestic production and overseas consumption seems to be counter to the original European availability and NATO interoperability considerations which were significant in the development of JP8 in the first place. The DoD should reassess the projection of 50% of JP8 supply from synthetic fuel by 1984.

DOD'S ROLE IN THE NATIONAL SYNTHETIC FUELS PROGRAM

The Energy Security Act provides a broad framework of law which loosely accommodates the interests of many sectors of the national economy including energy producing and energy consuming sectors. Government agencies, both new

and existing, will be required to work in concert toward the overall goal of national energy security. Executive orders, federal regulations, interagency agreements, memoranda of understanding and associated documents will be required to allow all the agencies involved to simultaneously cooperate to achieve the national goal while accomplishing their own missions.

DoD's interests in the overall program are complex. The Military Services' interests are to add domestic synthetic fuels to the potential fuel stocks to increase assurance of military fuel supply. The mandated DoD requirement is to be an early guaranteed market for synthetic fuels so that "consumer demand" will be an effective force in the overall government stimulation strategy. The two interests are not always consistent.

DoD will play a substantial role in the industry development program. The primary purpose of DoD's participation is to consume the early product during the period that industry development costs would keep its unsubsidized price higher than acceptable for general market penetration. The ESA provides that DoD will pay only the market price of the product being displaced by the synthetic fuel. The means to assure that this provision will be effected, so that DoD will not bear the marginal cost of industry subsidy, will take attention and skill on the part of DoD. It will be a challenge to DoD to derive a benefit from its consumption responsibility in proportion to the OSD, Military Department and Defense Fuel Supply Center attention that will be required to carry it out.

When the United States Synthetic Fuels Corporation (USSFC) assumes authority for industry development, and the Defense Production Act Amendments provisions are put into standby status, DoD retains a legal responsibility for participation in the development program. The ESA establishes an Advisory Committee to the Board of Directors of the USSFC. One of the six members is

required to be the Secretary of Defense. Another member will be the Secretary of Energy.

The Assistant Secretary of Energy for Resource Applications has announced that the Office of Resource Applications will serve as the Department of Energy "primary/programmatic interface with the emerging Energy Security Corporation".[5] Although significant cooperative work between DoD and DOE to initiate ESA programs is already underway, the work from the DoD point of view is being handled on an ad hoc basis. Members of the staffs of the Under Secretary of Defense (Research and Engineering), the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics), and the Defense Fuel Supply Center are participating.

The programs initiated by the Energy Security Act, however, are explicitly intended to stimulate the commercial production of synthetic fuel rather than to expand synthetic fuel development research. As service test programs are fulfilled, and the industry approaches a commercial level of production, the emphasis of the DoD participation will shift to operational use of synthetic fuels, with significantly higher rates of consumption. Logistics concerns--acquisition, transportation, storage, distribution--will begin to dominate military synthetic fuel activities just as they now dominate conventional petroleum fuels activities.

The research community currently provides the leadership of the DoD work in the area of synthetic fuel. As fuel testing is the dominant use of synthetic fuels in DoD, it is logical that the Office of the Under Secretary of

---

[5]Dr. Ruth M. Davis, Assistant Secretary of Energy for Resource Applications, address before the Synfuel Industry Development Seminar, February 28-29, 1980, Washington, D.C. The title "Energy Security Corporation" was used in some legislative proposals for the organization named the United States Synthetic Fuels Corporation.

Defense (Research and Engineering) should be the focal point for the development of department policy and provide the department interface with other agencies in the national effort. Once higher operational levels of consumption are reached and logistics considerations predominate, it would be expected that the synthetic fuels program leadership would shift to the logistics community, with the focal point being in the Office of Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics).

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Over the past ten years, the DoD has provided the only potential market interest in the shale oil industry. Now the effect of its interest is about to be multiplied in what may become the most financially ambitious joint government-industry undertaking the nation has ever experienced. The long-time military interest in the development of the oil shale as an alternate source of liquid hydrocarbon fuel will have served as a precursor to the stimulation of the industry. As the "Fast Start" provisions of the Defense Production Act Amendments give way to the supervision of the development of the industry by the United States Synthetic Fuels Corporation, it will be vital for DoD to have projected its needs carefully to assure that its long term interests are protected.

Although it is too early and too complex to determine, the rate of development of the national synthetic fuels industry probably will not be rapid enough to meet the production targets of the Energy Security Act. As the obstacles to the industry growth are met and overcome, however, synthetic fuels will become more plentiful. They probably will remain sufficiently more expensive than conventional fuels, requiring the subsidized DoD consumption to be a significant market force for years. As engine test programs conclude and allow the introduction of synthetic fuels to more applications, the logistics functions will predominate military synthetic fuels activity.

In view of the foregoing discussions, we recommend that the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) take the following actions:

* Develop a detailed, priority-ranked list of synthetic fuels requirements to satisfy all testing programs. Specifically, the Deputy Assistant Secretary of Defense (Energy, Environment and Safety) (DASD(EES)) should solicit the following information from the indicated organizations:

  - From the Deputy Under Secretary of Defense (Research and Advance Technology) (DUSD(R&AT)), a statement of synthetic fuel requirements to conduct all testing necessary to certify synthetic fuels for all anticipated applications. The amounts of fuel, specifications, desired delivery dates and locations, priority of need, and any other information necessary to define testing needs should be included. The information should be detailed enough so that fuel/volume/time/location increments can be identified. In addition to fuels for testing by Military Service test centers, synthetic fuels which could be provided as government furnished material for manufacturers' military engine development tests should be considered.

  - From the Commander, Defense Fuel Supply Center, a similarly detailed slate of fuels needed for tests to determine synthetic military fuels distribution and storage characteristics.

  Upon the assembly of all test fuel requirements, the DASD(EES) should, with the advice of the DUSD(R&AT), the Commander, DSFC, and other appropriate officials, such as the directors of the Military Service energy offices, determine an integrated priority ranking of testing requirements so that allocation plans for a range of early synthetic fuel supply levels can be made.

* Develop a basic profile for the operational introduction of synthetic fuels. Specifically the DASD(EES) should task the Commander, DFSC, to solicit from the Military Services a projection of petroleum needs which, on the basis of testing, could be effectively fulfilled by synthetic fuels. The data should be specific with respect to volumes, specifications, intermediate bulk storage and retail delivery locations, etc. This information should be used by the DFSC to develop incremental synthetic fuel consumption building blocks to allow efficient allocation of fuel for operational use over a range of supply profiles. The result of this military synthetic fuel market analysis should be combined with the results of the various test programs and the production projections of the USSFC as a basis for early acquisition and distribution planning by the DFSC. The DASD(EES) should include in his tasking to the Commander, DFSC, the requirement to resolve questions or possible impediments such as the ESA specification of "overseas supplies."

* Reevaluate synthetic fuel consumption projections at least annually to update acquisition and distribution planning. Specifically, the DASD(EES) should solicit the assistance of the DUSD(R&AT), the Commander, DFSC, and Service energy office directors to use test results, production levels and operational requirements to adjust acquisition and distribution plans.

* Plan for the shift of synthetic fuels program primary responsibility from the research community to the logistics community. Specifically, the DASD(EES) should work with the DUSD(R&AT) to identify the appropriate time to transfer primary DoD responsibility and spokesmanship for synthetic fuel to the DASD(EES) from the DUSD (R&AT).

APPENDIX

ASSESSMENT OF THE FEASIBILITY OF VARIOUS RATES OF THE SYNTHETIC FUELS INDUSTRY GROWTH

Several examinations of potential growth rates of the synthetic fuels industry in general, and of the shale oil industry in particular are available for study. This appendix presents summaries of three assessments--one private, one government and one academic.

Example 1 summarizes the report, Overview of Synthetic Fuels Production to 1990 by Pace Company Consultants and Engineers, Inc. The work was published in Synthetic Fuels, a report by the Subcommittee on Synthetic Fuels of the Committee on the Budget, U.S. Senate, dated September 27, 1979.

Example 2 summarizes the "Constraints to Development" section of the report, An Assessment of Oil Shale Technologies, by the U.S. Congress's Office of Technology Assessment.

Example 3 extracts the shale oil production rate projection of the Committee on Nuclear and Alternative Energy Systems of the National Research Council which was presented in its report, Energy in Transition 1985-2010.

A synthesis of the assessments is presented to conclude the Appendix.

Example 1

The Synthetic Fuels Task Force of the Senate Budget Committee asked the Pace Company Consultants and Engineers, Inc., a firm recognized for expertise in synthetic fuels for over twenty years, for answers to several questions including:

- What rate of synthetic fuel production could be achieved in 1985 and 1990 if existing impediments were removed?
- What is the maximum possible production which could be achieved in 1985 and 1990?

The answers to these and associated questions provide a concise summary of the synthetic fuels potential of the U.S. In order to assess the effects of three levels of effort toward the production of synthetic fuels, three cases were postulated:

> Case I - A good commercial test program will be initated, the objective being to establish a proven technology base which can be relied upon as the foundation for a synthetic fuels industry. Any project which is economically viable on its own merits will receive government encouragement, and a limited number of first-of-a-kind commercial plants will receive incentives. There will be no widespread removal of impediments. Promising technologies which are not currently economically viable, but which are expected to become so, will be supported by the government to establish a proven technology base which is operable at the commercial scale.
>
> Case II - A signficantly accelerated program, which in addition to establishing a strong technological basis, is intended to achieve a maximum production of synthetic fuels without incurring major distortions in the economy or infrastructure. Government action would be taken to remove impediments for such a program.
>
> Case III - A national "crash" effort would be undertaken to install maximum production capacity. Such an effort would be constrained only by the lack of resources, water supplies, logistical factors, or by the engineering and construction capabilities of the Nation. Distortions of the economy and infrastructure would be expected.

The overall estimates of the potential domestic production of liquid synthetic fuels for years 1985 and 1990 for each case are shown Table A-1.

To underscore the national economic effect of achieving Case III production rates (which are comparable to the rate to achieve the 1987 ESA goal, and only about one year more difficult than reaching the 1992 ESA goal), the following summary for the Case III capital investment requirements is extracted:

> "The probable capital investment required for a crash program is truly unpredictable. If the scoping costs used for Cases I and II are applied to a crash program, the capital investment would be 6.8 to 11.2 billion dollars by 1985, and 48.8 to 66.2 billion dollars by 1990. However, under a crash program, equipment shortages will abound, and the costs of building

synfuels plants will undoubtedly enter a period of hyperinflation."

TABLE A-1. POTENTIAL PRODUCTION OF LIQUID SYNTHETIC FUEL

	Production Potential (Thousand Barrels of Crude Oil Equivalent per Day)	
	1985	1990
CASE I		
Oil Shale	10- 25	100-200
Coal	50- 75	100-200
Oil Sands	-	-
Total	60-100	200-300
CASE II		
Oil Shale	45- 60	300-400
Coal	50- 75	400-450
Oil Sands	5	20
Total	100-140	720-870
CASE III		
Oil Shale	100-200	750-1,000
Coal	100-200	750-1,000
Oil Sands	10	50
Total	210-360	1,500-2,050

Example 2

The Office of Technology Assessment approached the question of "how much shale oil produced when?" by a different technique. Their report stipulates four different rates of shale crude production by 1990 and projects requirements for, and effects of reaching those target levels. One of their considerations is summarized in Table A-2.

Recognizing that the highest 1990 production rate considered by the Office of Technology Assessment is roughly comparable to the imputed shale contribution to the ESA 1992 production target, we see an argument which tends to confirm Pace's estimate of the unlikelihood of meeting ESA goals.

TABLE A-2. RELATIVE CONSTRAINTS TO IMPLEMENTING FOUR TARGETS FOR SHALE OIL PRODUCTION

Possible Deterring Factors	1990 Production Target (Barrels of Shale Crude per Day) 100,000	200,000	400,000	1 Million
	Relative Severity of Impediment[1]			
Technological	0	0	0	3
Financial & Economic	0.3	0.7	0.7	1.3
Institutional	0	0	1.2	3
Environmental	0	0	1	3
Water Availability	0	0	1.5	2
Socioeconomic	0	2	2	3
Total	0.3	2.7	6.4	15.3

NOTE:

[1]For each factor shown, several considerations were assessed. Relative severity was judged to be either NONE, POSSIBLE, MODERATE, or CRITICAL. For the purposes of this summary, demerit figures of 0, 1, 2, or 3, respectively, were assigned, and the average for each factor category shown.

Example 3

The National Research Council assembled a prestigious Committee on Nuclear and Alternative Energy Systems in 1975 at the request of Dr. Robert C. Seamans, then Administrator of the Energy Research and Development Administration to study a broad range of national energy options. Their report, Energy in Transition 1985-2010, is an extensive assessment of alternative energy strategies, considering many options individually and in competition with each other. The report states "it is difficult to predict the maximum production potential of oil shale ... quite modest--a maximum of three quads annually by 2010--even under national-commitment conditions." By ascribing the same energy value to shale oil as to a composite value for petroleum (one quad per approximately 172 million barrels) we see that this projection equates to a 2010 level of shale oil production of about 1.5 million barrels per day.

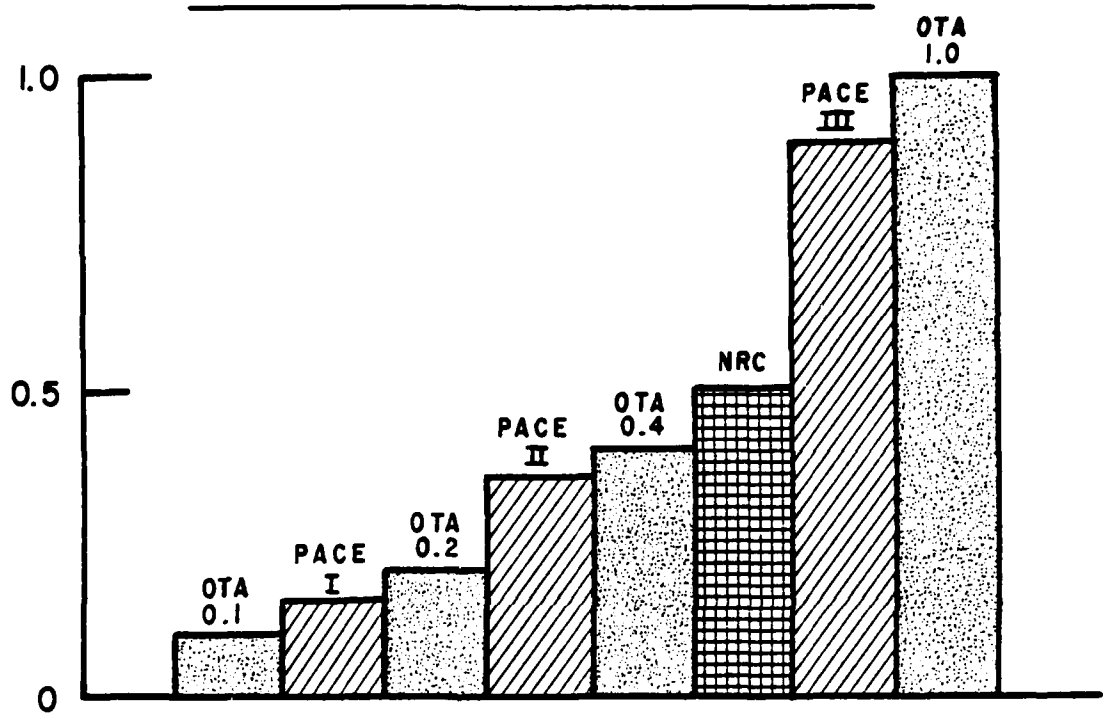
Synthesis

In order to compare the shale oil production rates addressed by the several reports which do not use the same year for future production estimates, Figure A-1 presents the 1990 production rates. The production rates displayed were either directly considered in the cited report or, for purposes of this comparison, are the result of straight-line averaging the production rate growth and using the 1990 result. Straight-line interpolation between the 1987 and 1992 ESA production targets gives a 1990 goal of about 1.5 million barrels per day (1.5 MB/D). Estimating the contribution needed from shale oil to fulfill that total projection at 50% puts the ESA 1990 shale oil production goal at approximately 0.75 MB/D, that is, about halfway between the NRC level and the PACE III level. The inference drawn from this synthesis is that shale oil production is unlikely to fulfill that target. If the estimated shale oil contribution were only 25% of the total, or about equal to the PACE II or OTA 0.4 production levels, even that production rate could not be fulfilled without substantial national commitment. Furthermore, any decrease in the shale oil share, such as from 50% to 25%, makes the contribution from other synthetic sources--principally coal and tar sands--correspondingly more difficult. In conclusion, it is unlikely that the shale oil production rate will have increased sufficiently by 1990 to reach half the projected ESA goal and, by extension, that the total synthetic fuel production will reach the 1990 projected goal level.

Figure A-1

COMPARISON OF 1990 SHALE OIL PRODUCTION RATES ASSESSED OR PROJECTED IN CITED REPORTS

(MILLION BARRELS PER DAY (MB/D))



KEY: PRODUCTION RATES

OTA 0.1, 0.2, 0.4 AND 1.0 MB/D TARGETS FROM TABLE A-2.
PACE I, II AND III - PACE CASES I, II AND III FROM TABLE A-1.
NRC 1.5 MB/D 2010 PROJECTION BACKED TO 1990.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ML010	2. GOVT ACCESSION NO. AD-AC 45713	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Development of Synthetic Fuels: Department of Defense Logistics Implications		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER LMI - ML010
7. AUTHOR(s) Connelly D. Stevenson		8. CONTRACT OR GRANT NUMBER(s) MDA-903-C-0370
9. PERFORMING ORGANIZATION NAME AND ADDRESS Logistics Management Institute 4701 Sangamore Road Washington, D.C. 20016		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs & Logistics)		12. REPORT DATE October 1980
		13. NUMBER OF PAGES 33
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

"A" Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Synthetic Fuels
Shale Oil
Energy Security Act

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Department of Defense (DoD) has been testing synthetic fuels, especially shale oil, since 1970. The DoD regards synthetic fuels as a potential alternative liquid hydrocarbon energy source, especially for mobility applications. The Energy Security Act (ESA) requires the DoD to consume a substantial portion of the initial output of synthetic fuels in order to provide a guaranteed market for the new industry. It is impossible to predict the

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract (Continued)

synthetic fuel production rate growth. The DoD should make incremental, flexible projections of synthetic fuel use rates, both for testing and for operational applications, in order to carry out its ESA responsibilities and simultaneously to exploit the synthetic fuels potential.